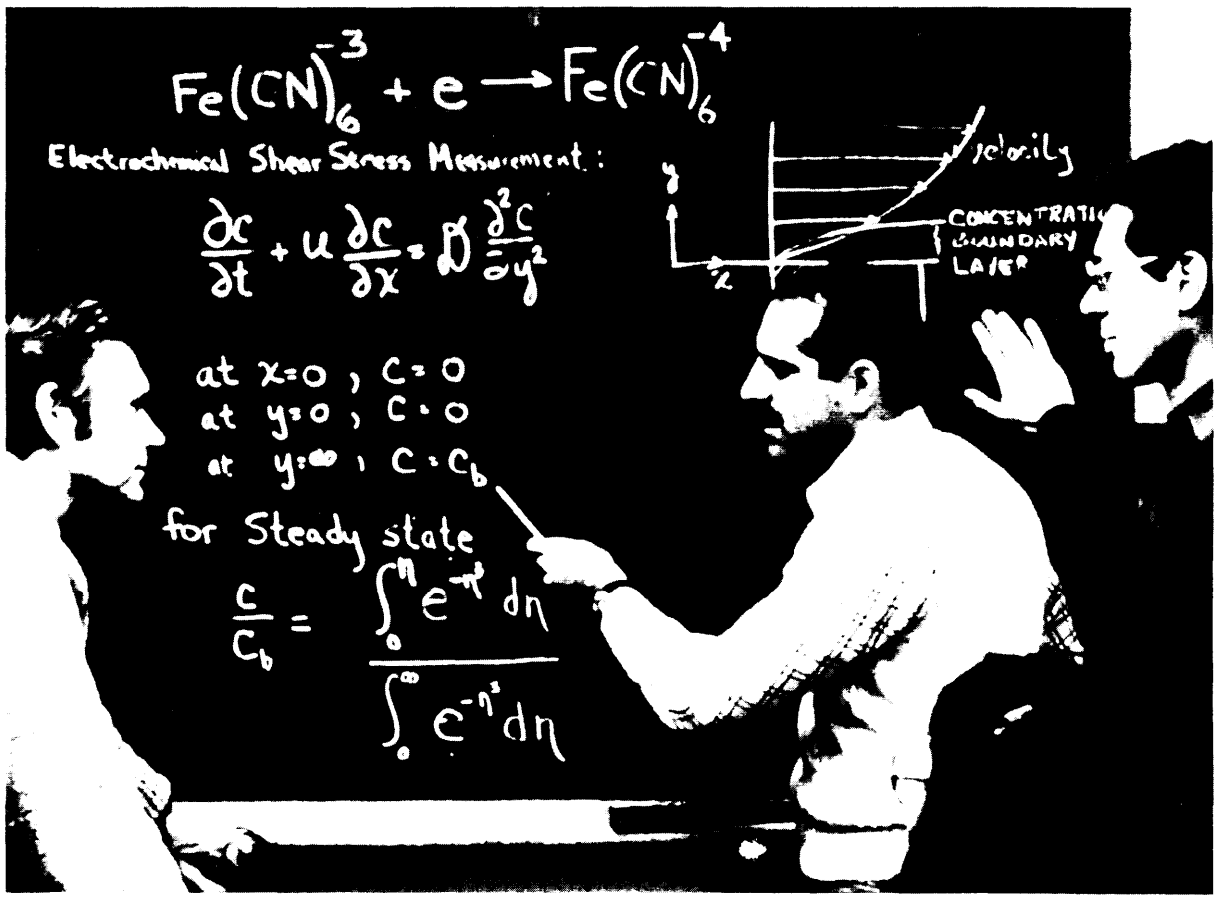
Chapter 6

Institutional Differences



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Chapter 6

Institutional Differences*

Research in the United States is performed in a number of different institutional settings—in university laboratories, in industry, in nonprofit institutions, and in government laboratories. The following profiles give examples of how some of the mechanisms described in chapter 4 apply in three different institutional settings. The profiles are based on interviews and data gathered in actual laboratories.

PROFILE OF A REPRESENTATIVE INDUSTRIAL LABORATORY

After acquisition in 1981 by a major international chemical firm, this laboratory was made part of a newly formed pharmaceutical products division. One of the largest U.S. producers of radioactive chemical compounds for life science research and radiopharmaceuticals, the pharmaceutical products division's research activities are principally aimed at new product development, at improving production efficiencies, and at developing radioisotope marking procedures for the fields of radiopharmacology, life science chemistry, and biotechnology. In addition, the division conducts research on industrial health and safety improvement techniques.

Because the Laboratory's primary function is to develop and supply radioactive materials, a large portion of the research is conducted to accomplish this corporate marketing or production objective. Some research is aimed at developing a marketable pharmaceutical that will receive U.S. Food and Drug Administration (FDA) approval. Other research seeks to improve the efficiency or safety of production processes. A small portion of the division's research is conducted under contract to other industrial firms, principally to develop product-specific radioisotope marking procedures usable in their own research.

Control of the Research Agenda

Because the laboratory is a commercial facility, its research decisions are strongly influenced by such considerations as the potential profit to be earned from new product sales, or the savings to be anticipated from production efficiencies and safety improvements. Funds for research are deemed an investment and, as such, are expected to pay dividends. The laboratory's research agenda therefore depends on corporate judgments concerning the potential of research to yield dividends.

In this regard, U.S. tax policy has, in recent years, promoted research investments by granting business deductions or credits for research expenditures—for example through the Internal Revenue Code and the 1981 Economic Recovery Tax Act (see ch. 4). The effect of these provisions is to lower the effective cost of research to businesses and thereby to make the research more likely to be profitable. To the extent that tax breaks are given without regard for the content of research, all forms of research are stimulated. Virtually all of this laboratory's research falls within the categories eligible for preferential tax treatment under current law.

The most important regulatory impacts on the selection of research opportunities at this laboratory, however, are the result of policies or regulations of FDA. By specifying the evidence of safety and efficacy it will require for new drug approval, the FDA sets forth much of the research agenda for product development. The FDA regulations also control the activities that may be undertaken with investigational new drugs. By specifying the protocols to be followed for each step of such research, including toxicology and pharmacology procedures for animal testing and use of human subjects, the FDA regulations chart the course of new drug development research.

*This chapter is based on the regulations in force in three different laboratories. Interviews and data collection were performed by Michael Baram and Raymond Miyares, Bracken & Baram, Boston, MA, under contract to the Office of Technology Assessment.

Outside of FDA requirements, the principal indirect impacts on the selection of research opportunities are higher costs resulting from compliance with health, safety, and environmental regulations. Sometimes firms engage in research in order to control and reduce these costs. For example, the high cost of hazardous and low-level radioactive waste disposal at licensed facilities stimulates interest in development, production, and recycling processes that produce less waste. At this laboratory, decisions to undertake research on ways to recover waste carbon isotopes and to reduce the curies of tritium used to produce tritium-marked products are attributable, in part, to waste disposal cost increases.

Regulations can also raise the cost of the research itself and thereby deter a firm from undertaking it. This firm, for example, has thus far declined to use P-3 level (high hazard) microorganisms in its biotechnology laboratory because of the elaborate substance approval process required by National Institutes of Health (NIH) guidelines. In interviews, company officials supplied other examples of research that they abandoned because of high regulatory compliance costs :

- The cost of establishing and maintaining a laboratory "closed box" acceptable under NIH guidelines and emission controls adequate to meet State air pollution requirements was deemed so substantial that planned research utilizing aflatoxins was abandoned.
- Similarly, the cost of obtaining an antidote for the venom of an African poisonous snake, in compliance with NIH guidelines, was considered prohibitive and research utilizing the venom was dropped.
- The Occupational Safety and Health Administration (OSHA) xylene and toluene exposure standards (to protect workers) were considered too costly to comply with in research on liquid scintillation cocktails, so that research was redirected to find scintillators with less toxic components.

Controls on the Research Process

The protocols specified in FDA regulations dictate not only the type of research necessary to support a new drug but also the research procedures to be utilized. Thus, to satisfy FDA, research must meet regulatory requirements for a "scientifically well controlled" study. Some of these steps are undertaken for no other reason than FDA requirements; in the absence of FDA regulation, the research might be designed in a more streamlined fashion.

For other types of research, regulatory requirements play a far less pervasive role. Research is designed so as to be most likely to yield the desired information. Because regulatory agencies have little interest in production efficiencies, much of the research conducted in this area, for example, is designed to suit the objectives of the researcher.

Management of Risks

Much of the division's research is undertaken by a permanent staff of scientists and technicians who expect a long-term career with the company. The long-term consequences of radiation and toxic chemical exposure are as important to them as immediate health and safety effects.

Since its acquisition by an international corporation, this laboratory has undertaken to conform its occupational and environmental health and safety practices to those of its parent company, which enjoys a national reputation for responsibility in this area. The laboratory has a safety executive committee of senior managers, with subcommittees on safety awareness, process hazards, equipment safety, chemical safety, and radiation safety. Every employee is required to attend a monthly safety seminar, and regular inspections are made, not only of the obvious hazards of chemical storage areas, radiation shielding, and electrical wiring, but also of the more mundane, such as chair hazards. On-the-job injuries, lost work time, restricted work time, medical treatment, and off-the-job injuries are reported monthly to corporate headquarters.

The laboratory workers are protected by several Federal and State regulatory programs. OSHA regulations, the most comprehensive of these, set general safety standards as well as exposure standards for toxic chemicals. Nuclear Regulatory Commission (NRC) regulations specifically gov-

ern the safety of laboratory work on radioactive materials and require dissemination of information to workers on any materials used in the laboratory and reporting of any incident involving radiation exposure. NIH guidelines govern the containment and security of micro-organisms used in biotechnology research.

The firm's preoccupation with safety also extends to environmental and community hazard concerns. The laboratory conducts annual emergency training programs for local fire officials, police, and hospitals. In addition, it complies with a panoply of Federal and State requirements for construction and operation of industrial facilities. The State plumbing code, for example, requires separate piping in the biotechnology lab for human contact and contact with organisms. The Resource Conservation and Recovery Act and corresponding State requirements, as well as NRC regulations, govern the disposal of hazardous and radioactive waste. Federal and State air quality regulations limit emission of radionuclides into the air. And, in addition, regulations under the Clean Water Act restrict the disposal of waste into publicly owned treatment facilities as well as the discharge of such waste into surface and groundwater. Under the Clean Water Act, even de *minimis* spills of hazardous substances must be reported.

Beyond these specific regulatory programs, the potential for liability under the Federal Superfund law, corresponding State laws, and the common law influences the management of laboratory risks. Such potential for liability provides an incentive for due care in the management and disposal of wastes and the emission of pollutants into the environment. However, the incentive operates further to cause the company to reduce waste generation so as to avoid strict liability even where due care has been exercised.

Restrictions on Communication of Information

As a manufacturer, the company is subject to both the OSHA hazard communication standard and the State's right-to-know law, notwithstanding that law's research laboratory component. Under both provisions, it must label—and supply its customers with Material Safety Data Sheets (MSDSs) on–all hazardous products sold. Company practice is to compile a notebook of MSDSs for all its products sold and to disseminate the same notebook to all customers with a printout listing which products they purchased during the previous 18 months.

The laboratory was in virtual compliance with the OSHA standard prior to its issuance and is encountering no significant difficulty in adapting its prior community liaison activities to the State's right-to-know requirements. For laboratory workers, it is required, under the OSHA standard, to:

- Ž ensure that labels on incoming containers of hazardous chemicals are not removed or defaced;
- maintain any MSDSs that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory workers; and
- provide laboratory workers with information and training on hazardous chemicals in their work areas at the time of their initial assignments, and when a new hazard is introduced into their work area.

The State has required further that the company supply a list of the hazardous substances that it uses, and an MSDS for each one, to local officials in both the State Capital and the town in which the lab is located. Neither the OSHA nor the State list of hazardous substances, however, includes radioactive materials.

Although the laboratory often seeks to disseminate a product developed in its research laboratories, corporate policy necessarily restricts dissemination of information about its research or about research results. Such information may be legally patentable or protectable as a trade secret, and corporate policy is to control dissemination or publication of research data, especially on process refinements or improvements, unless there is a valid business reason for dissemination. On the other hand, the parent company's policy is to disseminate fully any proven safety improvements developed by corporate research *laboratories.*

Again, the potential for liability affects the availability of information on research. The laboratory has a "document retention program" that

requires disposal of all documents not required to be retained for a business purpose or by regulation, the objective of which is to avoid a paper trail that could be used in enforcement or liability proceedings against the company. This program can be seen as a prudent response to the liberal discovery rights afforded litigants in the courts today, but it may also cause information on prior research to be lost to researchers within the company.

PROFILE OF A REPRESENTATIVE NONPROFIT INDEPENDENT LABORATORY

This cancer research center is one of several teaching hospitals affiliated with a major medical school, although its Board of Trustees is fully independent of the school. The center is involved in cancer research of virtually all types, from cell biology to clinical trials, with a special emphasis on childhood cancers. Its research divisions include specialities in: biostatistics and epidemiology; cancer control, genetics, and pharmacology; cell growth and regulation; immunogenetics; medical and pediatric oncology; medicine; and tumor immunology and virology.

The center administers an annual budget which, in 1984, exceeded $55 million. Of this amount, approximately 45 percent was for patient care and services and the remainder was for research. The center maintains a 57-bed inpatient facility and provided care through nearly 24,000 outpatient visits in 1984. Approximately 50 percent of the center's patients participate in some form of clinical study, however, and the line between research and patient care is not always precise.

Approximately 80 to 85 percent of the center's research is funded by Federal grants from NIH and the National Science Foundation (NSF). Of this amount, about 70 percent comes from the National Cancer Institute (NCI). Of the remainder, most comes from private granting organizations such as the American Cancer Society and the National Leukemia Foundation (principally for student fellowships). Approximatelys percent of research funds come from other private sources.

The center's therapeutic research often involves highly toxic chemical agents or radiation, and, of course, the use of human subjects. The hazards of the research may be concentrated on these subjects in some circumstances, and human subjects must be informed of, and consent to, acceptance of the related risks before participating in a clinical study in the hope of achieving therapeutic benefits.

The center's research staff of 600 includes approximately 350 with doctoral degrees. Much laboratory research is conducted by technicians. Such technicians typically have a high turnover rate, so that long-term exposure to laboratory chemicals and radiation is unusual. Nevertheless, some research personnel, both professional and nonprofessional, perform research over a period of several years.

Control of the Research Agenda

The center has a fairly formal administrative hierarchy that sets the general theme of the research to be undertaken. Because the center is itself mission-oriented (i. e., devoted to cancer research), and its principal funding sources share nearly the identical research mission, the center's broad outlines of research are not generally affected by considerations of funding availability. To be sure, the work of an individual researcher or laboratory might be terminated if funding were withdrawn. Much of the research staff is dependent on continuing funding for their employment. Further, if NCI were abolished or fundamentally redirected, the center's research agenda might be substantially affected. The importance of cancer research in American public health policy, however, makes the possibility of a major redirection remote.

Indeed, it is this public policy commitment, rather than the mission of funding sources, that appears to affect the center's selection of research opportunities. For example, the center has thus far declined to undertake a large amount of epi-

Box A.—An Assessment of Regulatory Forces by Lab Directors and Research Administrators

In March 1985, OTA sent questionnaires to 32 university research administrators (deans and vice presidents) and 112 laboratory directors around the United States. **The two groups were selected because of their varying roles in the university research process; administrators tend to be intimately involved in the research administration policies established and followed within the university and the lab directors are** more involved with concerns linked to their particular field. The laboratory director group was selected from the Gale 1984-85 Research Centers ***Directory*****. Out of the 7,427** entries for the United States and Canada, **at least two were chosen from every State and from the disciplinary** divisions according to the following proportions: agricultural **and nutrition sciences, s percent; astronomy, 5 percent; engineering (research), 20 percent; life sciences, 20 percent; mathematics and computer sciences, 20 percent; physics, 25 percent; and social sciences, 5 percent. Laboratories of all sizes were chosen randomly within the above parameters. The response rate for this group was 23 percent.**

The research administrators were chosen from the top 32 research universities in the country based on the level of Federal funding for research, according to the NSF *Academic Science R&D Funds: Fiscal Year* 1980, Surveys **of Science Resources Series. Forty-four percent of the research administrators responded to the survey. The aggregate response rate was 27.7 percent.**

Participants were asked to identify major regulatory forces in their research institutions, trends in regulation of research, and channels or forums for discussing solutions to potential problems. In general, there were few differences in the forces listed between the responses of the two groups.

Major Regulatory Forces.—The regulatory forces listed by the respondents can be classified into four major areas: controls on substance, whereby nonscientific forces are setting or influencing the research agenda; controls on process, whereby the nature of the research is not under consideration, but the means and methods used to accomplish the research goals are regulated; administrative constraints (including the funding process); and restrictions on dissemination of research results.

Clearly, the regulatory forces that are most keenly felt by both groups are the Federal guidelines for the protection of human participants and animals in research. But following closely in the ranking are many unintentional regulatory forces, such as environmental, health, and safety legislation intended to protect the general public; or radiation safety regulations, environmental and worker protection laws, and Good Laboratory Practice Standards intended to protect labor.

Administrative constraints were listed as a major area of concern by 37.5 percent of all respondents. Perhaps predictably, university administrators saw the financial accounting requirements as most pernicious. When the responses are disaggregate, 64 percent of the administrators v. 23 percent of the lab directors, listed financial accounting requirements as a major force.

Both groups found "social regulations" to play a major role, Social regulations include laws to encourage *small* business and minority business subcontracting, Fair Labor Standards, and Equal Employment Opportunity Commission and Affirmative Action requirements. Because respondents were not asked to rank their answers, it is not clear how much of a force they feel these regulations present. The frequency of responses, however, indicate that they are not as significant a force as the administrative and accounting requirements.

There was not a strong indication that either group feels that there are major regulatory forces affecting the research agenda, although a few respondents from each group indicated that national priority setting is increasingly affecting the research agenda, particularly as a result of increased defense spending and concern about industrial competitiveness. Only 17.5 percent of the respondents listed controls on dissemination of research results as a major force.

When asked whether they believed that the controls they had listed were any different from controls experienced by other universities, 86 percent of the administrators responded that they did not feel "singled out." The major regulatory forces affecting them are most likely the same for other research institutions.

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demiological research in the area of cancer prevention because of its doubts about the long-term commitment of NCI to such research. A cancer prevention epidemiological study would require a commitment to long-term funding without any important intermediate benefits to be derived from the research. National policy, in contrast, focuses on research with measurable output within a short time span, and the center has rot been satisfied that funding for cancer prevention or epidemiological studies would not be terminated before usable results could be achieved.

With this exception, the principal factor governing the choice of research activities is the individual strategy of the principal investigator. Because staff investigators are selected on the basis of the congruence of their expertise and interests with the center's research mission, the focus of its effort is maintained without any formal structure to review research proposals for consistency with the center's objectives.

Virtually all of the research conducted at the center is investigator-initiated, and very little is contract work. NIH and NSF proposals—as well as others—are peer reviewed, and this review, in some instances, may tend to discourage funding of highly innovative research projects in favor of more conventional undertakings. However, the vagaries of peer review are regarded as less influential on an organization such as this center than they might be for another research facility of lesser reputation.

The impact of all types of government regulation on the selection of research opportunities is also fairly minor. The cost of compliance with regulatory requirements is incorporated into grant applications and is rarely so significant that funding is jeopardized. Moreover, the very properties that make a substance or procedure a candidate for regulation often also make it attractive as a subject for research.

Control of the Research Process

Because NIH funding is so important to the center's research, the protocols established by that agency strongly influence the conduct of that research. Moreover, NIH guidelines have become, in many instances, the industry custom for laboratory research, and thus are followed even beyond the jurisdiction of NIH. NIH has published guidelines for animal testing, for the use of human subjects, for recombinant DNA research, and for the use of investigational drugs. The latter guidelines apply when NCI provides a pharmaceutical on which research is to be conducted; if an investigational drug were applied by a private firm, the firm would have to obtain FDA approval and meet FDA requirements established for such drugs. In general, the center attempts to relieve its researchers from the nonsubstantive burdens of these guidelines and to assign to administrative staff the responsibility for paperwork and managerial burdens.

A more fundamental effect on the conduct of research is perhaps caused by the structure of the usual grant agreement. Although NIH is authorized to make research grants for up to 7 years, the typical grant is generally for 3 to 5 years and never longer. On the average, an NIH grant provides 3½ years of funding. This limit is set, not so much by policy considerations, which arguably favor longer grants that are relatively easy to administer and require burdensome administrative procedures less frequently, as by the demands of peer review. Often reviewers recommend funding for less than the total period of time requested in order to allow for thorough review at frequent intervals. A possible impact of such temporal limits, however, is to promote research protocols that permit tangible work products in shorter time periods.

A principal limitation of NIH funding is that it does not fully cover experimental patient care. This is not a reflection of any NIH judgment that it is not responsible for experimental patient care, but rather a dictate of the limitations of available funds. Third-party procedures (e.g., Medicaid and Blue Cross/Blue Shield), in contrast, do not assume responsibility for experimental clinical procedures. Thus, a gap exists, at least in theory, between NIH funding and third-party procedures. In practice, the gap is less significant than it appears, in part because the line between clinical research (nonreimbursable) and "best patient care" (reimbursable) is not precisely drawn. However, as pressure to control medical costs increases, third-party providers are likely to draw a more restrictive line of distinction and more experi-

mental patient care may have to be funded by NIH.

Management of Risks

The center is subject to OSHA, the Environmental Protection Agency, and NRC regulations governing work place safety, environmental protection, and radiological health. The center's Division and Laboratory Chiefs are responsible for assuring compliance with such regulations by those they supervise. In addition, the center is subject to the Joint Committee on Hospital Accreditation, a hospital self-regulating organization that approves radiation, chemical, and biological safety programs. The State and city in which the laboratory is located further regulate aspects of health, safety, and environmental hazards, including fire and chemical hazards and the biohazards of recombinant DNA.

As noted, NIH guidelines govern the use of human subjects in research, and these guidelines generally require the approval of the research protocol by an Institutional Review Board and the informed consent of the human subject or legal representative. Typically, the center has found, its patients are relatively sophisticated about the nature of their disease, the hazards of research, and the potential for harm. The center is a tertiary care facility, and the majority of its patients have substantial experience with medical procedures and treatments. Therefore, the content of its informed consent form can sometimes be relatively more technical than corresponding documents at other facilities such as at a primary care hospital.

The informed consent form states the center has "no formal policy" with regard to compensation of research subjects who are injured in the course of research. In practice, medical cost incurred as a result of such injury might be paid by the third-party provider. In particular circumstances, however, the center might seek to assume or divide these costs.

Controls on Communication of Information

Because the center regards its staff to be both intelligent and well-educated, it relies on the provision of chemical and radioactive hazard information as the principal instrument for managing risk hazard. The center employs one half-time chemical safety information officer whose exclusive responsibility is to provide relevant information about substance hazards and appropriate precautions and responses, as well as to perform laboratory inspections.

The center, however, is not subject to either the OSHA hazard communication standard or the State right-to-know law. The OSHA standard, as noted, applies only to workers within the manufacturing sector. The State law exempts research laboratories not involved in the production or manufacture of goods for direct commercial sale. The regulations issued under the law require an application for an exemption to be filed by each laboratory. The center has filed such an application and, while that application is pending before the State department of public health, the center is exempt from right-to-know requirements.

A principal objective of the research conducted at the center is the dissemination of user results. Dissemination serves the interests of the center's mission by advancing the state of knowledge about cancer and also enhances the reputation and standing of the center and its staff. Therefore, the center will not accept research funding that requires secrecy. Nevertheless, some limits on dissemination are accepted. Grant agreements may specify, for example, that publication of research results might be delayed for up to 3 months in order to allow for review by the sponsor. Such limits do not generally appear in NIH or NSF grant agreements. Indeed, the policy of Federal funding organizations is to stimulate the dissemination of research results, and failure to publish may be considered negatively in evaluation of new grant proposals.

A theoretical restriction may also derive from the practice of some center staff to consult privately for industry. In such circumstances, the staff member could feel disinclined to publish results seemingly adverse to private clients. Such an impact may be completely unconscious and impossible to demonstrate, but the restriction may nevertheless operate.

PROFILE OF A REPRESENTATIVE UNIVERSITY LABORATORY

The Department of Chemical Engineering at this major research university engages in a range of research projects and activities in support of the academic development and advancement of its students and faculty. Although much of this research is funded from outside sources, the department does not principally engage in client services, but rather seeks grant support for research into chemical transformation and separation processes, and energy intensive functions of relevance to the interests of its members. The principal areas of interest include coal conversion, synfuels developments, utilization of micro-organisms in chemical processes, and polymer production. Approximately **30** to **40** percent of the department's research funds come from private sources (e. g., one international corporation contributes $1 million annually); the remainder are Federal grants, principally from the departments of Energy and Defense (DOE and DOD) and NSF.

Much of the department's research is conducted at a very small scale, utilizing small quantities (often less than a gram) of chemicals in any particular step. However, a great variety of chemicals are involved in the department's research programs so that the cumulative hazard of the research is highly variable. An exception to this pattern of low volume and high variety is in the area of combustion engineering, in which substantial volumes of petroleum products are burned in the course of research.

In many instances, laboratory research is conducted by students rather than by staff technicians. Because the turnover rate for both students and technicians is fairly high, most of the people who work in the department's labs are not subject to long-term exposure to laboratory chemicals. The students, however, may be more vulnerable to risks because they are relatively naive and untrained in laboratory safety procedures and may be somewhat less cognizant than career workers of the hazards of their research. This situation influences the amount and type of safety measures taken by the university.

Controls on the Research Agenda

Because the university lacks the formal hierarchical administrative structure of a commercial enterprise, decisions to undertake research are relatively individual and idiosyncratic, rather than directed by an overall institutional strategy. Clearly, the availability of funding affects the research agenda, but this financial incentive differs from that of an industrial laboratory, which must make its research choices based, in part, on an estimate of the market impact of the anticipated results. Further, because of its stature in academic circles, the department carries considerable weight in negotiations with potential sponsors over the content and conduct of its research activities.

This is not to say that research sponsors have no influence over the manner in which their funds are utilized. Many Federal sponsors and some foundations, as well as virtually all commercial sponsors, are mission-oriented. Such sponsors make their grant awards based on whether they perceive the research to promote their particular mission objectives. Approximately **75** to ***80*** percent of the department's research funds come from such mission-oriented sponsors, which include DOD and DOE, the petroleum and chemical manufacturing industries, integrated circuit manufacturers, and pharmaceutical companies. The remainder comes from sponsors seeking to support "basic" research–some DOE programs, NSF, and private foundations.

The impact of regulation on the selection of research opportunities is, by contrast, fairly minor compared to the academic interests of the faculty and the mission objectives of sponsors. Because the department's research seeks to be at the cut-

ting edge, regulation addressing the specific substances or processes under investigation may not yet have been developed. The cost of complying with health, safety, and environmental regulations is rarely so significant that research is foreclosed. To the extent that such regulation raises the cost of certain lines of inquiry and thus may divert attention to other research activities, this effect is countered somewhat by intellectual interest in studying "problem" chemicals and process—those that may be the subject of extensive regulatory attention.

Because combustion engineering research has different characteristics from other research conducted in the department, the effect of regulation of this research is also somewhat different. In particular, research into the emissions produced by combustion processes requires the use of substantial volumes of fuel. Often, from a purely research perspective the fuel of choice would be benzene, but benzene is the subject of such intense regulatory scrutiny that researchers are reluctant to use it if a relatively less problematic alternative such as toluene is available. This reluctance stems both from current regulatory activities (principally by OSHA) and from the concern that department researchers share with regulators over the hazards of the substance.

A similar effect may be discerned with respect to the use of radioisotopes in research. Because of the regulatory burden of becoming licensed to handle radioisotopes and the cost of their disposal under NRC regulations, their use is discouraged if alternative research procedures are available. Again, the effect may be to skew the allocation of research resources.

Controls on the Research Process

Most research grant agreements specify how research activities are to be conducted; but the level of specification varies considerably with the sponsor. Sponsors of basic research typically require a proposal that sets forth the research protocol in sufficient detail to allow reviewers to judge the technical adequacy of the research. Such protocols are often thereafter incorporated by reference into grant agreements, but most sponsors do little supervision or monitoring of performance under these agreements.

Industrial sponsors may provide "foundation" grants intended to support the department's general research activities, rather than any particular project. Such broad grants are less likely to constrain the specific conduct of research. When industrial sponsors underwrite a particular research project, however, the grant agreement may include specification of the research protocol. Surveillance of the department research, however, is somewhat more extensive in that reporting requirements are more often imposed and site visits more frequent.

Mission-oriented Federal agencies, such as DOD and DOE, tend to specify research protocols in the greatest detail. Such protocols are drafted, not only to assure the technical adequacy of the research, but also to assure that research results will be usable by the sponsor in achieving its objectives. Commonly specified details include performance requirements, cost allocations, equipment, milestones, and personnel. This greater specification is typically accompanied by greater supervision and monitoring of the research. The Department of Defense is especially strict in its surveillance of the research it sponsors; however, this university does not automatically comply with DOD's (or any other sponsor's) requests for secrecy in the conduct of research. Because it is an academic institution principally devoted to education, the university laboratories are widely open to students and faculty. Classified or weapons-related research is deemed an inappropriate activity for an academic institution, although it may be conducted at university affiliated laboratories off campus.

Management of Risks

The university maintains a Safety Officer and an Office of Environmental Medical Services which are intended as a resource to consult in the design of laboratory risk management activities and to facilitate compliance with environmental, health, and safety regulations. In addition, the university faculty maintains nine standing committees that develop risk management procedures to be used in research:

- Council on Environmental Health and Safety,
- Committee on Assessment of Biohazards,

- Committee on Radiation Protection,
- Committee on Safety,
- Committee on Animal Care,
- Committee on the Use of Humans as Experimental Subjects,
- Committee on Toxic Chemicals,
- Committee on Radiation Exposure to Human Subjects, and
- Committee on Reactor Safeguards.

The university will not approve a grant agreement or research contract that has not been approved by the committee having jurisdiction over such research.

In general, the safety practices established by these offices and committees are equivalent to, or more stringent than, corresponding regulatory requirements. Often, the faculty have been involved in the development of Federal regulatory requirements and their influence is reflected in the requirements adopted. Nevertheless, researchers are always alert to proposals for regulatory requirements that specify unachievable standards or unworkable administrative burdens, For example, a new State plumbing code originally would have required that no micro-organisms be disposed of in the wastewater of laboratories where biotechnological research was being conducted, even though there are safe and acceptable levels of micro-organisms commonly allowable in wastewater generated by nonresearch facilities.

The department's laboratories are subject to a range of environmental and occupational safety and health requirements that typically include: 1) safety or health standards for emissions of, or exposure to, a particular substance; and 2) documentation of compliance with such standards. Many of these regulations specify the chemical substance as the unit of regulatory attention, and the paperwork burden of reporting requirements varies with the number of chemical substances used in research. Because department research typically utilizes tiny quantities of a multitude of chemical substances, the paperwork burden is substantial even though the exposure and emission standards may be fairly easy to achieve.

An example is provided by the regulations under the Resource Conservation and Recovery Act (RCRA) for hazardous waste disposal. These regulations essentially prohibit the disposal of substances on the hazardous waste list by conventional means (emission standard =0) and instead require that licensed hazardous waste transporters and disposal facilities be utilized. The regulations further specify the packaging and paperwork requirements to be followed in the disposal of hazardous wastes. At this university, hazardous waste from chemical engineering laboratories is sent to the safety office where such waste is collected from all parts of the university. Much of this waste is unique and packaged in tiny vials. Traditional practice has been to combine vials of compatible wastes in "laboratory packs''—conventional drums lined with absorbent material—before shipping them off for disposal. The regulatory manifest, however, requires that the contents of each vial in the lab pack be separately identified, and monthly and annual generator reports required under RCRA also must include information on each vial. Because the waste in each vial may be unique, the information necessary to complete the manifest may not be routinely available, and the safety officer may encounter some difficulty in preparing the waste for shipment. A barrel of industrial waste, in contrast, is likely to contain only one waste type that is routinely generated. The paperwork burden for this barrel is correspondingly light: Only one substance needs to be identified on the manifest and the information to be provided is the same day after day.

Similarly, the State's Clean Air regulations require an individual permit for each vent through which air pollution emissions are made. The university has approximately 20 such permits for the Department of Chemical Engineering and each one is supposed to include a specification of the substances being emitted as well as the technology being employed to reduce those emissions. Because laboratory work varies over time, however, any specification of substances in the permit is necessarily uncertain. Moreover, if an honest effort is made to specify all of the substances likely to be utilized in the laboratory, the permit application must then demonstrate that the technology is in place to reduce emissions of the full list of substances. Nothing in this State law exempts from the permit requirement substances that are being emitted in *de minimis* quantities.

Essentially, these two environmental regulatory programs were devised with a different model of facility in mind; it is increasingly apparent that regulations devised for industrial facilities may be poorly suited for application to research laboratories. RCRA regulations do include a partial exemption for small quantity generators, but this is of no use to the university, which clearly does not qualify as a small generator because of its substantial total volume of waste. If paperwork burdens are to be more closely related to the hazards of the regulated activity, new efforts are required to tailor regulatory requirements to the type of enterprises being regulated.

One such effort is suggested by the statement of projected rulemaking issued by OSHA on April 29, 1985, concerning health hazards of chemicals in laboratories. In that statement, OSHA observed:

> Existing OSHA standards are designed to protect employees who are engaged in work involving exposure to only a few toxic chemicals during relatively standardized, continuous or repetitive processes. In contrast, laboratory workers are exposed to a multitude of toxic substances under frequently changing or unpredictable conditions. OSHA will examine whether prudent work practices and protective equipment, chosen for the specific facility and task, are more effective, feasible and economical for laboratory work than adhering to OSHA's current substance specific exposure standards.

Such a proposal appears to be better suited to achievement of the goals of environmental, health, and safety regulations than the traditional approaches. The effect of traditional regulations, in many instances, is to consume the time of safety personnel in the documentation of compliance rather than to stimulate such people to devote their time to analyzing problems for which routinized solutions are not readily achievable.

Restrictions on Communication of Information

It is the formal written policy of the university that people who may be exposed to hazards should be informed about the nature of these hazards and how to protect themselves and others who also may be exposed. Faculty, administration, and research supervisory personnel are responsible for promoting safe practices and for informing individuals working in laboratories about safety in connection with the work being conducted.

This policy derives from the university's assessment of its own responsibility under ethical and general liability principles rather than from a particular hazard disclosure regulation or statutory requirement. For example, the OSHA hazard communication standard applies only to workers within the manufacturing sector. Therefore, no university laboratory is subject to its requirements.

Similarly, the State right-to-know law exempts research laboratories not involved in the production or manufacture of goods for direct commercial sale. The regulations issued under the law require an application for exemption to be filed by each laboratory. The Department of Chemical Engineering has filed such an application for its laboratories, which is presently pending before the State Department of Public Health (DPH). Under the regulation, the department is exempt until DPH rules on the application.

Nevertheless, the State law does affect university operations in other ways. A number of vendors have terminated all business in the State in response to the law, so that alternative vendors have had to be found in some instances. In addition, MSDSs being supplied with chemical products sometimes appear to have been prepared by lawyers to achieve minimal compliance with regulatory standards and to provide the least incriminating information possible, rather than by persons desirous of promoting proper management of substance hazards. For this reason, when the university is establishing safety procedures, it frequently uses MSDSs prepared by an independent service, rather than those supplied by manufacturers.

Clearly, a principal objective of academic research is publication and dissemination of research results both to advance the state of knowledge in the research field and to advance the reputation and study of the department and its faculty. As noted, therefore, the university will not approve

funding arrangements that require secrecy in the conduct of research and the dissemination of results.

Nevertheless, some limits on dissemination are common. Grant agreements may specify, for example, that publication of research results must await a release by the sponsor. In some circumstances—for example, where proprietary information has been licensed to the department for the conduct of research—the sponsor may require that articles proposed for publication be submitted for review in advance to assure that inappropriate disclosures of patentable material or trade secrets are not made.

The department's agreement with the corporation cited above, for example, illustrates how these provisions operate. Under that agreement, the university will hold the patent on any discovery made in the course of the research funded by the corporation, subject to the corporation's royalty-free license. If the university does not develop its patent, then the rights will revert to the corporation. The corporation is also given 10 days to review articles proposed for publication and to make any objections. Of course, the principal restraint on publication under this arrangement may not be the final restrictions of the grant agreement but the desire to maintain a harmonious relationship with a major source of research funding.